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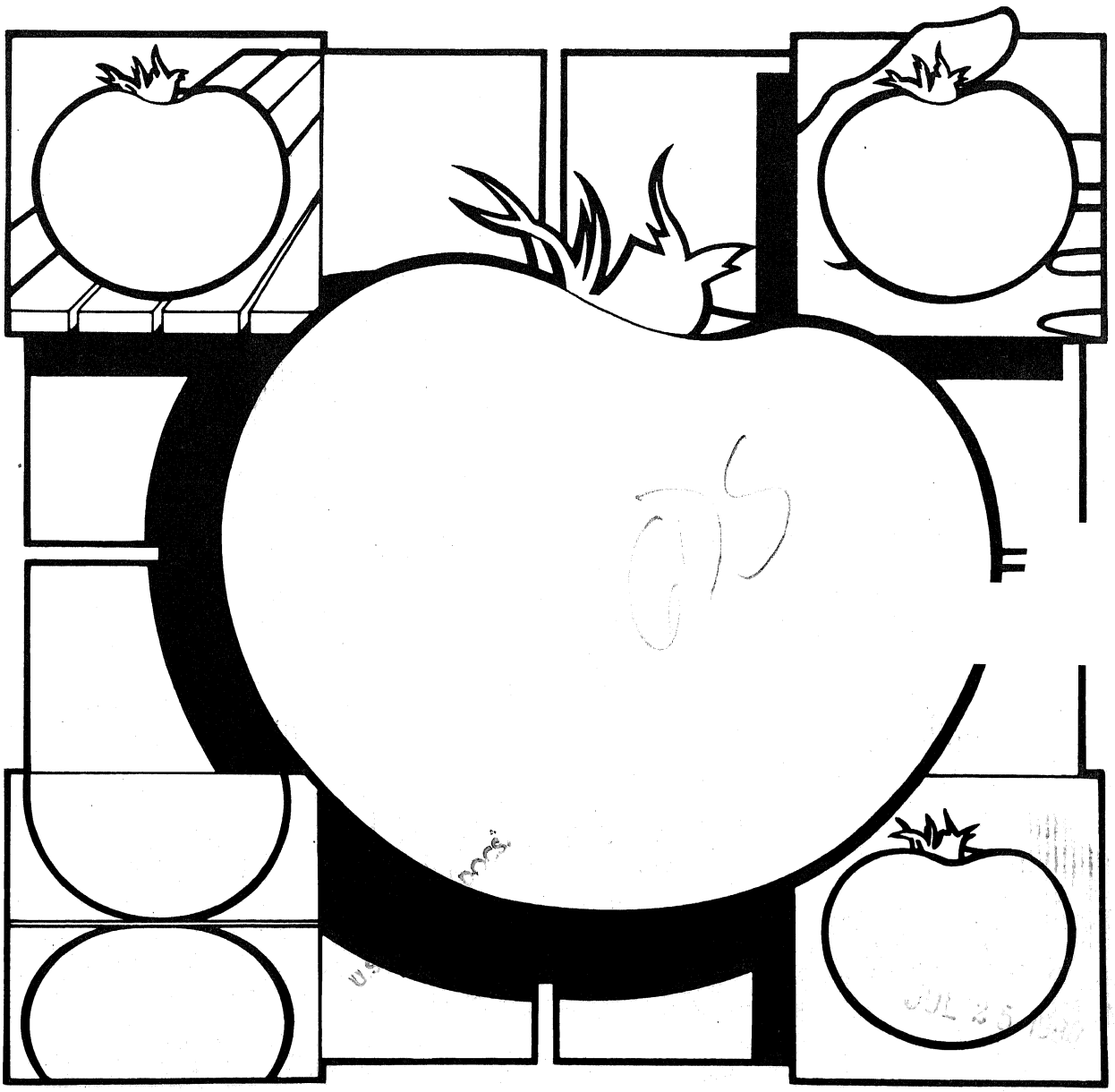
A Comparison of Handling Systems for Fresh Tomatoes From Packing Plant to Retail Store



Acknowledgment

Acknowledgment is made to the shippers, carriers, and receivers of fresh tomatoes who made their facilities available for this study.

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A Comparison of Handling Systems for Fresh Tomatoes From Packing Plant To Retail Store

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Summary

Labor, equipment, and materials costs were developed for 12 systems of handling, transporting, and delivering fresh tomatoes. The systems included four tomato handling methods (handstacked, palletized, pallet-pool, and slipsheet) from the packing plant to wholesale warehouses, three systems (handstacked, palletized, and mobile carts) for handling tomatoes from wholesaler to retailer, and one system used in the retail store.

A synthesized pallet-pool system was the lowest-cost system ($0.6218 per 20-pound carton) for moving tomatoes from packing plant to wholesaler. Pallet delivery was the lowest cost system ($0.2278 per carton) for movement from wholesaler to retailer, and $0.1756 per carton for handling at the retailer level gave the lowest total labor, equipment, and materials cost of $1.0252 per carton.

The pallet-pool system is not new, but has never been successfully operated industry-wide. This system is not considered feasible at this time. Therefore, the handstack system, which costs $0.6249 per carton, is recommended for delivery of fresh tomatoes from packing plant to wholesale warehouse. The recommended delivery system from wholesale warehouse to retailer is pallet delivery ($0.2278 per carton). The total system cost, then, would be $1.0283 per carton (packing plant to wholesale warehouse $0.6249, wholesale warehouse to retailer $0.2278, and retail handling $0.1756).

Total costs per carton ranged from $1.0252 to $1.1384.

Wholesale and retail losses due to damage and decay were not included in the cost calculations. If included, these losses would have increased the costs per carton for each of the 12 systems. Because of reduced handling, some systems offer better protection for the fruit than other systems.

LIBRARY KEYWORDS: Fresh tomatoes, systems, handling, transporting, delivery costs.

Introduction

In the United States the tomato is a leading fresh market vegetable with an average (1976) annual production of over 2 billion pounds valued at $425 million. Many tomato varieties are available for year-round fresh market sale. These include cherry, round, and pear-shaped tomatoes in various shades of red or yellow. Those most commonly found in retail stores are pink or light red, round, and average about three inches in diameter.

Most fresh tomatoes are moved from producing areas to final destination by truck. This publication covers the labor, equipment, and materials costs of transporting fresh tomatoes by four shipping systems (handstacked, wooden expendable pallets, pallet-pool, and slipsheets) from the packing plant to the wholesale warehouse, three delivery systems (handstacked, palletized, and mobile carts) from warehouse to the retail store, and handling in the retail store.

The research was done in southern Florida, the Rio Grande Valley in Texas, and the Washington, D.C., metropolitan area. It is part of a continuing research program of the U.S. Department of Agriculture, which is designed to find more efficient and less costly systems for handling agricultural products from producer to consumer.

The results indicate the requirements at the particular facilities studied. Use of the same systems at different facilities may give slightly different results.

Methodology

In this study, the shipping systems from packing plant to wholesale warehouse consist of loading, transporting, and unloading. Loading started when the fresh tomatoes were taken from the end of the packing line or storage and moved into the transport vehicle. Loading was completed when the last carton was securely in place in the transport vehicle, the dock plate removed, and the trailer doors closed.

Transportation of the fresh tomatoes started when the transport vehicle left the loading area at origin and ended with the arrival at the wholesale warehouse. Transportation was the same for all four systems. A refrigerated highway trailer, 40 feet long, was the transport vehicle.

Unloading at the wholesale warehouse started when the trailer doors were opened and the dock plate positioned; it was completed when the last carton was in place in the warehouse storage area.

These handling systems from packing plant to wholesale warehouse were analyzed to measure the costs of labor, equipment, and materials, based on 900 twenty-pound cartons per trailer load. The worker-hour labor requirements were converted to costs using the prevailing wage rates for these job categories as reported by cooperating packing plants and wholesale warehouses. A 15 percent fatigue and personal allowance was added to all labor requirements to provide a standard time for performing various operations. The equipment-hour requirements were converted to costs using hourly ownership and operating costs developed in table 15.

The handling systems from wholesale warehouse to retail store consisted of order assembly, stock replenishment, loading, transportation, and unloading. Order assembly began when the first carton was selected as part of a full trailer load. Assembly ended when the last carton was selected. Loading, transportation, and unloading had the same parameters as the loading, transportation, and unloading mentioned above.

To facilitate comparison of over-the-road shipping systems, only one shipping point (Miami, Fla.) and one receiving point (Washington, D.C.) were used. To determine the least costly system, various packing plants, wholesale warehouses, and retail stores were selected for detailed analysis.

The size carton used in this study was the 20-pound capacity fiberboard carton. Tomatoes within it were either in a consumer pack or wrapped individually (fig. 1 and 2).

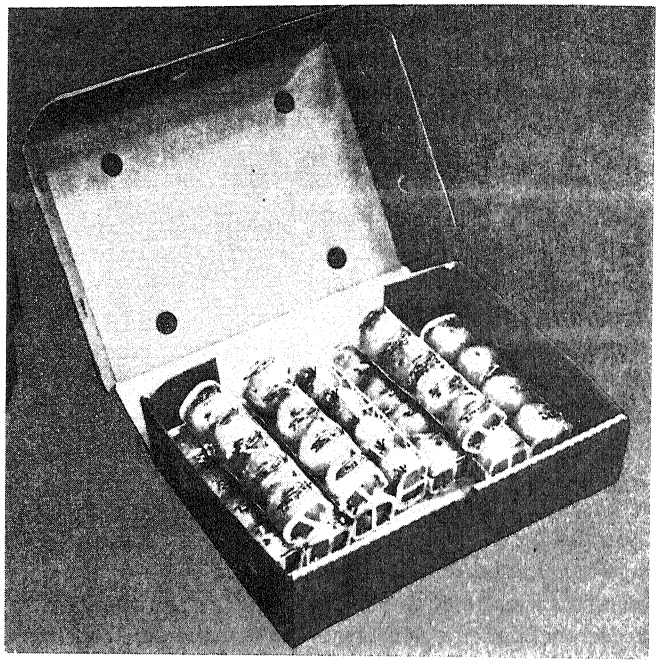

Figure 1. Twenty-pound carton with consumer packs inside.

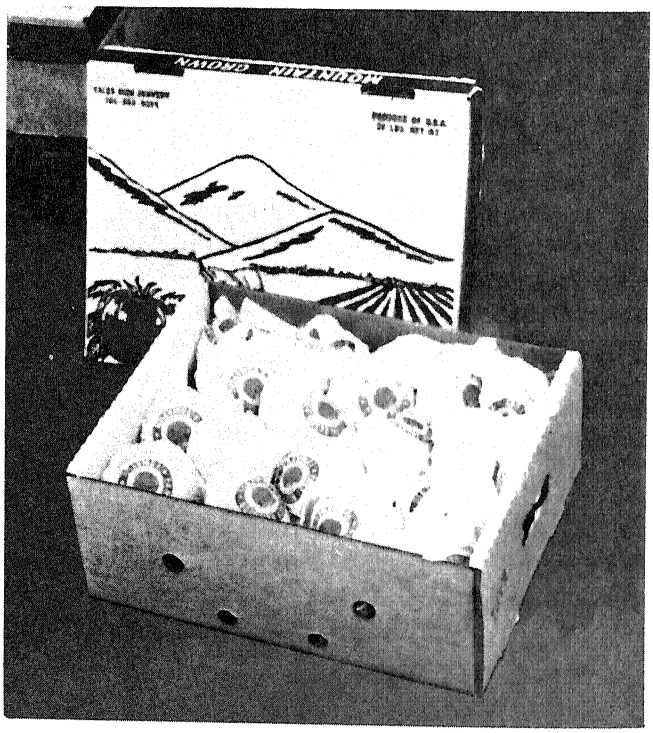

Figure 2. Twenty-pound carton with individually wrapped tomatoes.

Packing Plant To Wholesale Warehouse

Each of the four handling and shipping systems from packing plant to wholesale warehouse consisted of three basic elements—loading, transportation, and unloading. The four handling systems include hand-stacking, palletized, pallet-pool, and slipsheet.

Handstacked System

In this system a forklift truck carried a pallet unit into a refrigerated highway trailer at the packing plant (fig. 3). Two workers then removed the cartons of fresh tomatoes and stacked them in the trailer. Empty pallets were removed from the trailer by a forklift truck. The labor and equipment cost to load 900 cartons was $8.48, as shown in table 1.

At a rate of $0.60 per carton to transport fresh tomatoes from central Florida to Washington, D.C., the cost to transport the 900-carton trailer load was $540.

At the wholesale warehouse, after the rear doors of the trailer were opened (fig. 4) and the dock plate positioned, warehouse personnel or the truck driver secured a stack of pallets and positioned them on the loading dock near the rear of the trailer. As a pallet was needed, the driver either hand-carried it into the trailer or moved it with a pallet jack. Assisted by a helper, the driver handstacked the tomato cartons on the pallet (fig. 5). When the pallet was loaded (fig. 6), it was removed from the trailer with an electric pallet jack and moved to temporary storage (fig. 7). From temporary storage a warehouse employee transports the full pallet into storage.

The labor and equipment costs to unload 900 cartons from a refrigerated highway trailer are shown in table 2. Total cost to stack the cartons on the pallets, remove from the trailer, and transport to storage was $13.95. Of this amount, labor cost to handstack cartons on pallets was $8.64 or 62 percent of the total cost at the wholesale warehouse.

The cost of the handstacked system to handload the cartons in the trailer at the packing plant ($8.48), transport ($540), and unload by hand at the wholesale warehouse ($13.95) totaled $562.43. Cost per carton was $0.6249 ($562.43 ÷ 900).

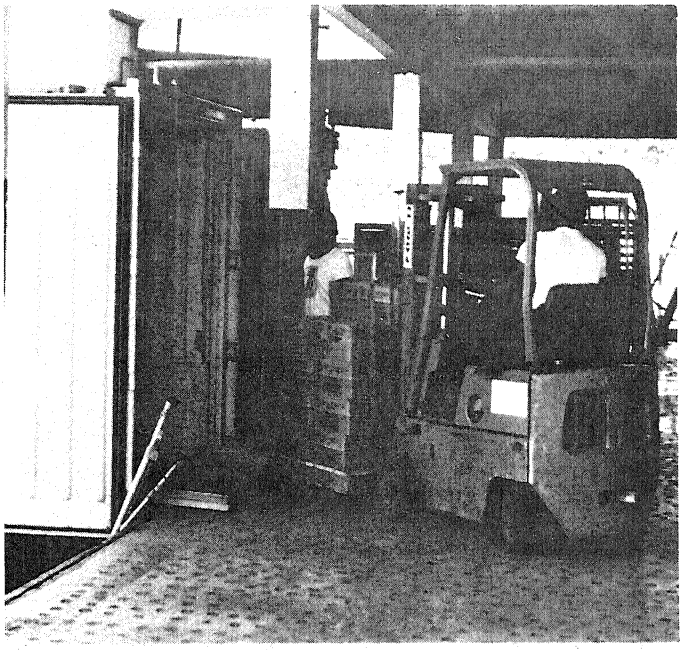

Fig. 3. Forklift truck transporting a pallet unit to a trailer at packing plant.

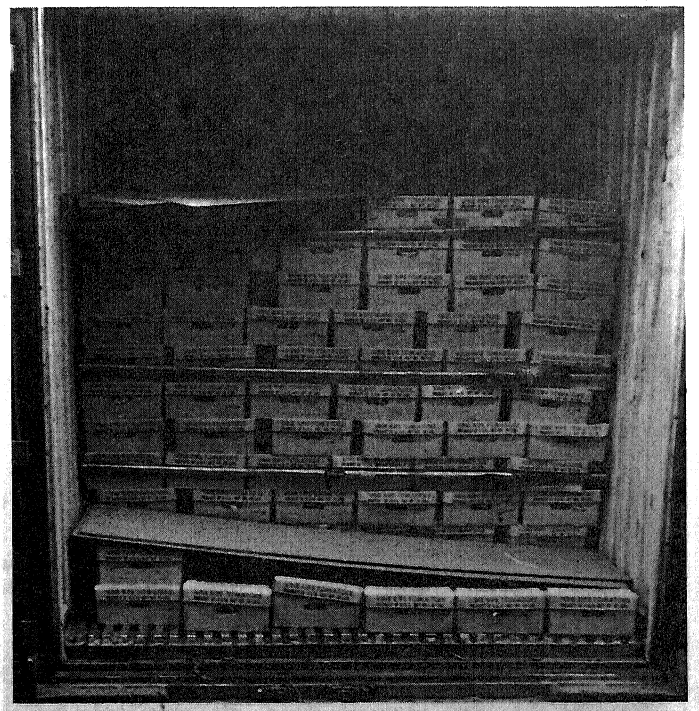

Figure 4. Trailer load of tomatoes being backed up to unloading dock at a wholesale warehouse.

Figure 5. Handstacking cartons of tomatoes onto a pallet in a trailer at a wholesale warehouse.

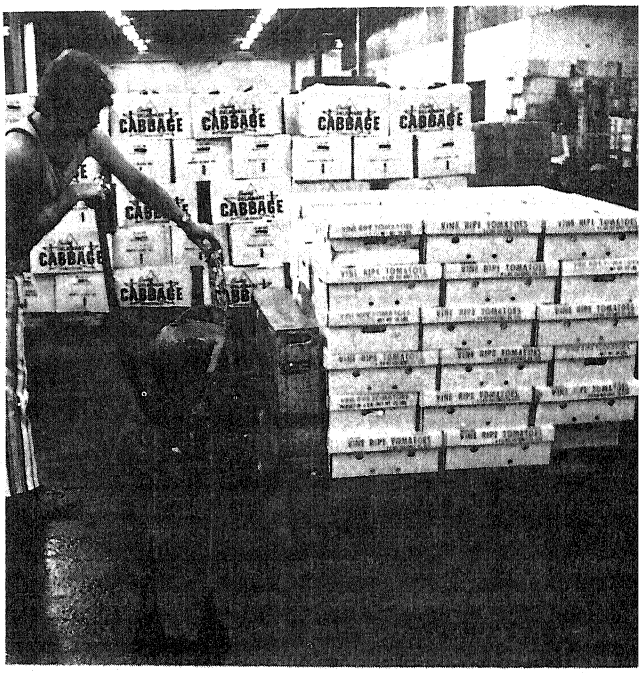

Figure 7. Pallet load of tomatoes being moved to temporary storage.

Figure 6. Fully loaded pallet of tomatoes before movement to temporary storage.

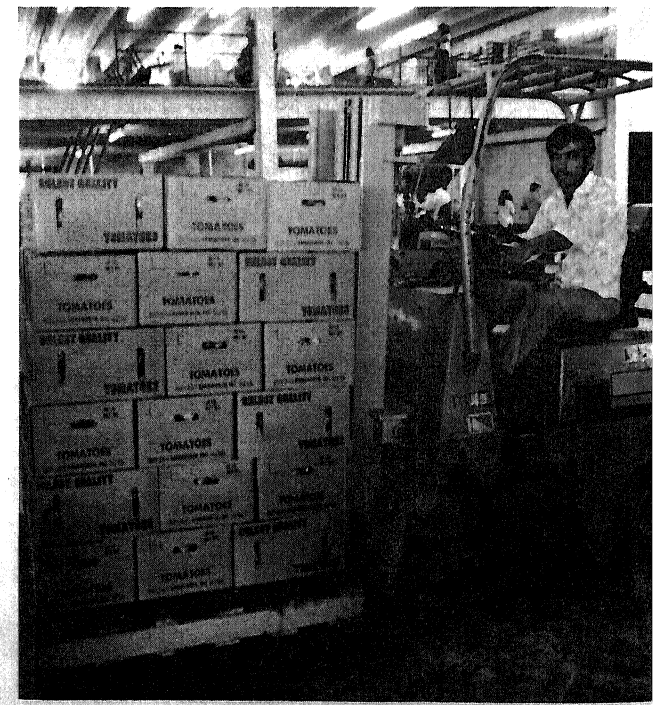

Figure 8. Pallet load of fresh tomatoes before loading in trailer.

Table 1. Handstacked system: Labor and equipment time and cost to transport 900 palletized cartons of fresh tomatoes from storage and handstack in trailer at packing plant[1]

Element	Labor		Equipment		Total cost
	Time	Cost	Time	Cost	
	Worker-hours	Dollars	Hours	Dollars	Dollars
Transport cartons from storage into truck by forklift truck (round trip 175 feet)	0.48	1.92	0.48	0.60	2.52
Handstack cartons in trailer from pallets	1.26	5.04	.53[2]	.66	5.70
Remove empty pallets from trailer	.05	.20	.05	.06	.26
Total	1.79	7.16	1.06	1.32	8.48

[1] Labor and equipment costs, respectively, at $4 and $1.25 per hour.

[2] During handstacking in trailer, forklift truck occasionally remained in trailer.

Table 2. Handstacked system: Labor and equipment time and cost to unload 900 handstacked cartons of fresh tomatoes and move to storage

Element	Labor		Equipment		Total cost
	Time	Cost[1]	Time	Cost[2]	
	Worker-hours	Dollars	Hours	Dollars	Dollars
Position dock plate and remove brace bars	0.02	0.12	—	—	0.12
Position pallets	.06	.36	—	—	.36
Handstack cases on pallets (50 cartons per pallet for 18 pallets) and apply warehouse location sticker on load	1.44	8.64	—	—	8.64
Remove pallet load from trailer by pallet jack (18 round trips of 125 feet each)	.24	1.44	0.24	0.13	
Move loaded pallet from temporary storage by forklift truck, place in storage racks, and return (18 round trips of 200 feet each)	.45	2.70	.45	.56	
Total	2.21	13.26	.69	.69	

[1] At $6 per hour.

[2] At $0.53 per hour for pallet jack and $1.25 per hour for forklift truck.

Palletized System

In this system the cartons of tomatoes are stacked on wooden pallets (fig. 8) and loaded into the highway trailer by a forklift truck at the packing plant. The labor and equipment cost to load 900 cartons unitized on 18 pallets was $5.36 as shown in table 3.

A disposable 48- by 40-inch wooden pallet costing $4.50 each was used in this system. Total cost for 18 disposable pallets was $81.

At a rate of $0.60 per carton to transport fresh tomatoes from central Florida to Washington, D.C., the transportation cost to transport a 900-carton trailer load was $540. It was assumed that no charge was made for the extra weight of the pallets. If a charge were made for the additional weight, the cost per carton would increase.

At the wholesale warehouse, pallet loads that had not shifted during transit were easily moved from the trailer to the dock by one worker using an electric pallet jack (fig. 9). From the dock or temporary storage, the palletized cartons were transported with a forklift truck and positioned in the storage racks (fig. 10). Pallet loads on the floor were used in order selection. As bottom pallets were emptied, loads above were lowered for order selection.

The labor and equipment costs to unload 900 palletized cartons from a refrigerated highway trailer are shown in table 4. Total cost to move the pallet loads from the trailer and transport to storage was $6.39.

The cost of the palletized system to load at the packing plant ($5.36), plus the pallet cost ($81), transportation ($540), and unloading at the wholesale warehouse ($6.39) totaled $632.75. Cost per carton was $0.7030 ($632.75 ÷ 900).

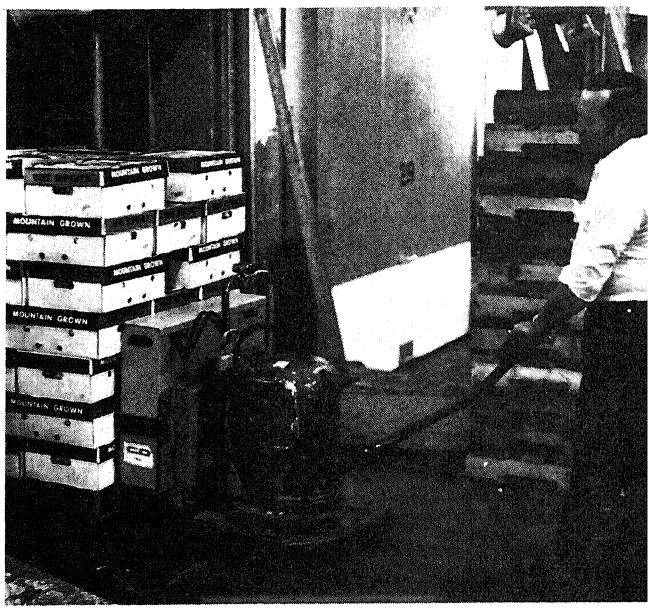

Figure 9. Removing a palletized load of fresh tomatoes from trailer.

Figure 10. Palletized cartons of fresh tomatoes in storage.

Table 3. Palletized system: Labor and equipment time and cost to transport 900 palletized cartons of fresh tomatoes from storage and load in trailer at packing plant[1]

Element	Labor		Equipment		Total cost
	Time	Cost	Time	Cost	
	Worker-hours	Dollars	Hours	Dollars	Dollars
Transport cartons from storage to dock by forklift truck (round trip: 175 feet)	0.48	1.92	0.48	0.60	2.52
Move 18 loaded pallets into trailer by forklift truck	.54	2.16	.54	.68	2.84
Total	1.02	4.08	1.02	1.28	5.36

[1] Labor and equipment costs, respectively, at $4 and $1.25 per hour.

Table 4. Palletized system: Labor and equipment time and cost to unload 900 palletized cartons of fresh tomatoes and move to storage

Element	Labor		Equipment		Total cost
	Time	Cost[1]	Time	Cost[2]	
	Worker-hours	Dollars	Hours	Dollars	Dollars
Position dock plate and remove brace bars	0.02	0.12	—	—	0.12
Pickup palletized units with pallet jack, move from trailer (18 round trips of 125 feet)	.24	1.44	0.24	0.13	1.57
Straighten cartons on pallet at dock	.22	1.32	.22	.12	1.44
Move loaded pallet to storage by forklift truck, place in racks, and return (18 round trips of 200 feet)	.45	2.70	.45	.56	3.26
Total	.93	5.58	.91	.81	6.39

[1] At $6 per hour.

[2] At $0.53 per hour for electric pallet jack and $1.25 per hour for forklift truck.

Pallet-Pool System

This system was synthesized from the data gathered on the palletized system. A hypothetical pallet-pool arrangement is used in the pallet-pool system in place of the expendable pallet used in the palletized system.

The representative pallet in this synthesized system was a 48- by 40- by 5-inch, 4-way entry, with an average weight of 80 pounds. Pallet expenses were assumed to consist of a purchase price of $8 per pallet and repairs and expenses of $8 per pallet for 36 uses. This totals $16 per pallet. The resulting per-use cost is $0.44 ($16 ÷ 36). Total cost per use of the pallets for 18 units was $7.92.

Also, it was assumed, as in the palletized system, that no additional transport charge was made for the extra weight of the pallets during shipment.

Cost of the pallet-pool system to load at the plant ($5.36), plus the cost of the pallets ($7.92), transport ($540), and unload at the wholesale warehouse ($6.39) totaled $559.67. Cost per carton was $0.6218 ($559.67 ÷ 900).

Slipsheet System

In this system a forklift truck with a push-pull attachment pulled the palletized unit onto the tines of the forklift truck. The unit was transported into the highway trailer and positioned. Cost of 18 slipsheets (payload surface 48 inches by 40 inches) at 65 cents each for a full trailer load was $11.70.

Labor and equipment cost to load 900 cartons of fresh tomatoes unitized on 18 slipsheets is shown in table 5. Labor and equipment costs totaled $7.04.

At a rate of $0.60 per carton to transport fresh tomatoes from central Florida to Washington, D.C., the cost to transport the 900-carton trailer load was $540.

At the wholesale warehouse, a forklift truck with a slipsheet attachment transported the slipsheet unit from the trailer and positioned it on a pallet. The loaded pallet was picked up by a conventional forklift truck and moved into storage.

Labor and equipment costs to unload 900 cartons, unitized on slipsheets from a refrigerated highway trailer, are shown in table 6. Total cost to move the slipsheet loads from the trailer and move to storage was $11.40.

Cost of the slipsheet system to load at the packing plant ($7.04), plus the cost of the slipsheets ($11.70), transportation ($540), and unloading at the wholesale warehouse ($11.40) totaled $570.14. Cost per carton was $0.6334 ($570.14 ÷ 900).

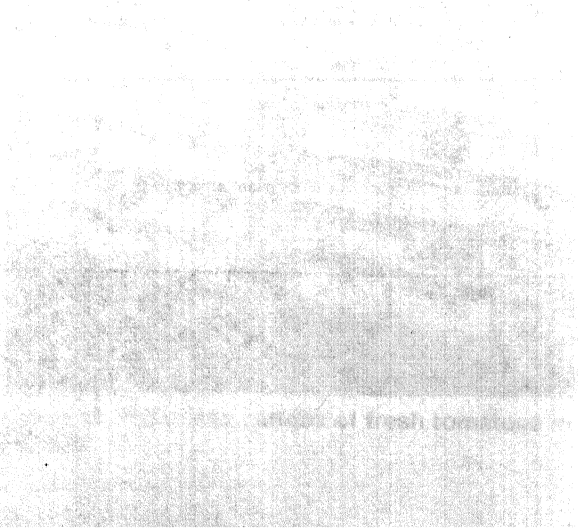

Table 5. Slipsheet system: Labor and equipment time and cost to transport 900 unitized cartons of fresh tomatoes from storage and load in trailer at packing plant[1]

Element	Labor		Equipment		Total cost
	Time	Cost	Time	Cost	
	Worker-hours	Dollars	Hours	Dollars	Dollars
Transport cartons from storage to dock by forklift truck with slipsheet attachment (round trip: 175 feet)	0.48	1.92	0.48	0.74	2.66
Move 18 loaded slipsheets into trailer with forklift truck with slipsheet attachment[2]	.79	3.16	.79	1.22	4.38
Total	1.27	5.08	1.27	1.96	7.04

[1] Labor at $4 per hour and $1.55 per hour for forklift truck with slipsheet attachment.

[2] Some time data from ARS-NE-47, A Cost Comparison of Alternative Systems for Shipping Citrus in Refrigerated Highway Trailer Vans. 1974.

Table 6. Slipsheet system: Labor and equipment time and cost to unload 900 cartons of fresh tomatoes on slipsheets and move to storage

Element	Labor		Equipment		Total cost
	Time	Cost[1]	Time	Cost	
	Worker-hours	Dollars	Hours	Dollars	Dollars
Position dock plate	0.02	0.12	—	—	0.12
Manually position 18 pallets on dock	.12	.78	—	—	.78
Transport 18 slipsheet loads from trailer to dock and place on pallets using a forklift truck with slipsheet attachment (18 round trips of 125 feet)	.79	4.74	0.79	0.99[2]	5.73
Straighten cartons on pallet at dock	.20	1.20	.20	.31[2]	1.51
Move loaded pallets to storage by forklift truck, place in storage racks, and return (18 round trips of 200 feet)	.45	2.70	.45		
Total	1.58	9.54	1.44		

[1] At $6 per hour.

[2] $1.55 per hour for forklift truck with slipsheet attachment.

[3] $1.25 per hour for forklift truck.

Wholesale Warehouse To Retail Store

This section of the report is concerned with the handling and transporting of fresh tomatoes from the storage area at the wholesale warehouse to temporary storage at the retail store. Labor and equipment costs were developed for the three major systems for movement of the product from wholesaler to retailer. The three systems are: (1) handstacked delivery, (2) palletized delivery, and (3) mobile cart delivery.

Handstacked Delivery System

In this system of delivery, the cartons of tomatoes and other cases of produce are selected and placed on four-wheel selector trucks that were pulled by an electric tugger. One worker on the dock took cases and cartons of the mixed load from the selector trucks and stacked them in the trailer.

After the trailer was fully loaded, it was driven to a parking area. From this area the trailer was driven to the retail stores for unloading. At the retail store, trailer unloading was accomplished using a gravity roller conveyor. The labor requirements and costs to select, restock, load, deliver, and unload a trailer with 1,000 cases and cartons (of which 75 are cartons of fresh tomatoes) are shown in table 7. Labor costs per 75 cartons of tomatoes were $7.92 or $0.1056 per carton.

Table 8 shows the equipment time and costs for the handstacked delivery system operations. Equipment cost per tomato load was 28 cents or $0.0036 per carton.

The transport trailer made an 80-mile round trip during the delivery. With a fixed cost of $3.12 per hour for tractor and trailer for 8 hours (8 X $3.12 = $24.96) total fixed cost was $24.96. Operating cost was $1.57 per mile. Total ownership and operating cost for the delivery trip was $150.56 or $0.1506 per carton.

The total labor, equipment, and transport cost to deliver handstacked fresh tomatoes to the retail store from the wholesale warehouse was $0.2598 per carton (labor = $0.1056, equipment = $0.0036, transportation = $0.1506).

Palletized Delivery System

In this system of delivery, the cartons of fresh tomatoes and other cases of produce are selected and stacked on pallets that were then transported by a pallet jack to the loading dock (fig. 11) and into the trailer. All movement was accomplished with the use of an electric pallet jack.

At the retail stores the pallets are unloaded by one worker using a pallet jack and transported to temporary storage. The labor requirements and costs to select, restock, load, deliver, and unload a trailer with 1,000 cases and cartons, of which 75 are cartons of tomatoes, are shown in table 9. Labor costs per 75 cartons of tomatoes were $5.46 or $0.0728 per carton.

Table 10 shows the equipment time and costs for the palletized delivery system operations. Equipment cost per tomato load was 34 cents or $0.0044 per carton.

The transport trailer made an 80-mile round trip during the delivery. With a fixed cost of $3.12 per hour for tractor and trailer for 8 hours (8 X $3.12 = $24.96), total fixed cost was $24.96. Operating cost was $1.57 per mile. Total ownership and operating cost for the delivery trip was $150.56 or $0.1506 per carton.

The total labor, equipment, and transport cost to deliver fresh tomatoes on pallets to the retail store from the wholesale warehouse was $0.2278 per carton (labor = $0.0728, equipment = $0.0044, transportation = $0.1506).

Figure 11. Pallet load before being moved into trailer.

Table 7. Labor requirements and costs for selecting, stock replenishment, loading, delivering, and unloading handstacked cartons of fresh tomatoes from warehouse to retail store as part of a mixed-produce trailer load[1]

Element	Per trailer load[2]	Per tomato load	Cost[3] Per tomato load	Cost[3] Per tomato carton
	Worker-hours	Worker-hours	Dollars	Dollars
Select cases of produce and stack on selector trucks pulled by electric tugger	5.08	0.38	2.28	0.0304
Stock replenishment	.73	.05	.30	.0040
Load cases into trailer	2.58	.19	1.14	.0152
Deliver to store and return	3.20	.24	1.44	.0192
Unload at store	6.08	.46	2.76	.0368
Total	17.67	1.32	7.92	.1056

[1] Trailer load consists of 1,000 cases and cartons of produce, of which 75 are tomato cartons.

[2] Shaffer, P. F. and D. M. Steckler, Comparative methods of Handling Produce from Warehouse Slots to Holding Areas in Retail Store. ARS-NE 49, November 1974.

[3] At $6 per hour.

Table 8. Equipment time and costs for selecting, loading, and unloading handstacked cartons of fresh tomatoes from warehouse to retail store as part of a mixed-produce trailer load

Element	Per tomato load	Cost per tomato load[1]	Cost per carton[2]
	Hours	Dollars	Dollars
Use of electric tugger	.38	.19	.0025
Use of four-wheel selector trucks	1.14	.01	.0001
Roller conveyor for unloading	.45	.08	.0010
Total	1.97	.28	.0036

[1] At $0.49, $0.005, and $0.18 per hour for the first, second, and third cost data, respectively.

[2] For 75 cartons.

Wholesale Warehouse To Retail Store

This section of the report is concerned with the handling and transporting of fresh tomatoes from the storage area at the wholesale warehouse to temporary storage at the retail store. Labor and equipment costs were developed for the three major systems for movement of the product from wholesaler to retailer. The three systems are: (1) handstacked delivery, (2) palletized delivery, and (3) mobile cart delivery.

Handstacked Delivery System

In this system of delivery, the cartons of tomatoes and other cases of produce are selected and placed on four-wheel selector trucks that were pulled by an electric tugger. One worker on the dock took cases and cartons of the mixed load from the selector trucks and stacked them in the trailer.

After the trailer was fully loaded, it was driven to a parking area. From this area the trailer was driven to the retail stores for unloading. At the retail store, trailer unloading was accomplished using a gravity roller conveyor. The labor requirements and costs to select, restock, load, deliver, and unload a trailer with 1,000 cases and cartons (of which 75 are cartons of fresh tomatoes) are shown in table 7. Labor costs per 75 cartons of tomatoes were $7.92 or $0.1056 per carton.

Table 8 shows the equipment time and costs for the handstacked delivery system operations. Equipment cost per tomato load was 28 cents or $0.0036 per carton.

The transport trailer made an 80-mile round trip during the delivery. With a fixed cost of $3.12 per hour for tractor and trailer for 8 hours (8 X $3.12 = $24.96) total fixed cost was $24.96. Operating cost was $1.57 per mile. Total ownership and operating cost for the delivery trip was $150.56 or $0.1506 per carton.

The total labor, equipment, and transport cost to deliver handstacked fresh tomatoes to the retail store from the wholesale warehouse was $0.2598 per carton (labor = $0.1056, equipment = $0.0036, transportation = $0.1506).

Palletized Delivery System

In this system of delivery, the cartons of fresh tomatoes and other cases of produce are selected and stacked on pallets that were then transported by a pallet jack to the loading dock (fig. 11) and into the trailer. All movement was accomplished with the use of an electric pallet jack.

At the retail stores the pallets are unloaded by one worker using a pallet jack and transported to temporary storage. The labor requirements and costs to select, restock, load, deliver, and unload a trailer with 1,000 cases and cartons, of which 75 are cartons of tomatoes, are shown in table 9. Labor costs per 75 cartons of tomatoes were $5.46 or $0.0728 per carton.

Table 10 shows the equipment time and costs for the palletized delivery system operations. Equipment cost per tomato load was 34 cents or $0.0044 per carton.

The transport trailer made an 80-mile round trip during the delivery. With a fixed cost of $3.12 per hour for tractor and trailer for 8 hours (8 X $3.12 = $24.96), total fixed cost was $24.96. Operating cost was $1.57 per mile. Total ownership and operating cost for the delivery trip was $150.56 or $0.1506 per carton.

The total labor, equipment, and transport cost to deliver fresh tomatoes on pallets to the retail store from the wholesale warehouse was $0.2278 per carton (labor = $0.0728, equipment = $0.0044, transportation = $0.1506).

Figure 11. Pallet load before being moved into trailer.

Table 7. Labor requirements and costs for selecting, stock replenishment, loading, delivering, and unloading handstacked cartons of fresh tomatoes from warehouse to retail store as part of a mixed-produce trailer load[1]

Element	Per trailer load[2]	Per tomato load	Cost[3] Per tomato load	Cost[3] Per tomato carton
	Worker-hours	Worker-hours	Dollars	Dollars
Select cases of produce and stack on selector trucks pulled by electric tugger	5.08	0.38	2.28	0.0304
Stock replenishment	.73	.05	.30	.0040
Load cases into trailer	2.58	.19	1.14	.0152
Deliver to store and return	3.20	.24	1.44	.0192
Unload at store	6.08	.46	2.76	.0368
Total	17.67	1.32	7.92	.1056

[1] Trailer load consists of 1,000 cases and cartons of produce, of which 75 are tomato cartons.

[2] Shaffer, P. F. and D. M. Steckler, Comparative methods of Handling Produce from Warehouse Slots to Holding Areas in Retail Store. ARS-NE 49, November 1974.

[3] At $6 per hour.

Table 8. Equipment time and costs for selecting, loading, and unloading handstacked cartons of fresh tomatoes from warehouse to retail store as part of a mixed-produce trailer load

Element	Per tomato load	Cost per tomato load[1]	Cost per carton[2]
	Hours	Dollars	Dollars
Use of electric tugger	.38	.19	.0025
Use of four-wheel selector trucks	1.14	.01	.0001
Roller conveyor for unloading	.45	.08	.0010
Total	1.97	.28	.0036

[1] At $0.49, $0.005, and $0.18 per hour for the first, second, and third cost data, respectively.

[2] For 75 cartons.

Table 9. Labor requirements and costs for selecting, loading, delivering, and unloading palletized cartons of fresh tomatoes from warehouse to retail store as part of a mixed-produce trailer load[1]

Element	Per trailer load[2]	Per tomato load	Cost[3] Per tomato load	Cost[3] Per tomato carton
	Worker-hours	Worker-hours	Dollars	Dollars
Select cartons of product and stack on pallets	4.87	0.36	2.16	0.0288
Stock replenishment	.73	.05	.30	.0040
Load palletized units into trailer	.62	.05	.30	.0040
Deliver to store and return	3.39	.25	1.50	.0200
Unload at store	2.65	.20	1.20	.0160
Total	12.26	.91	5.46	.0728

[1] Trailer load consists of 1,000 cases and cartons of produce, of which 75 are tomato cartons.

[2] Shaffer, P.F. and D.M. Steckler, Comparative Methods of Handling Produce from Warehouse Slots to Holding Areas in Retail Store. ARS-NE-49, November 1974.

[3] At $6 per hour.

Table 10. Equipment time and costs for selecting, loading, and unloading palletized cartons of fresh tomatoes from warehouse to retail store as part of a mixed-produce trailer load

Element	Per tomato load	Cost per tomato load[1]	Cost per carton[2]
	Hours	Dollars	Dollars
allet jack	0.61	0.32	0.0042

Mobile Cart Delivery System

In this system of delivery, the cartons of fresh tomatoes and other cases of produce are selected and loaded onto mobile carts that were then transported to the loading dock and loaded onto the trailer. All movement was accomplished with the use of an electric tugger.

At the retail store the carts were unloaded across a truck bed-level dock. The carts were then transported to temporary storage in the store.

The labor times and costs to select, restock, load, deliver, and unload a trailer with 1,000 cases and cartons, of which 75 are cartons of fresh tomatoes, are shown in table 11. Labor costs per 75 cartons of tomatoes were $5.88 or $.0784 per carton.

Table 12 shows the equipment times and costs for the mobile cart delivery system operation. Equipment cost per tomato load was 59 cents or $0.0078 per carton.

The transport trailer made an 80-mile round trip during the delivery. With a fixed cost of $3.12 per hour for tractor and trailer for 8 hours (8 X $3.12 = $24.96), total fixed cost was $24.96. Operating cost was $1.57 per mile. Total ownership and operating cost for the delivery trip was $150.56 or $0.1506 per carton.

The total labor, equipment, and transport cost to deliver fresh tomatoes to the retail store from the wholesale warehouse was $0.2368 per carton (labor = $0.0784, equipment = $0.0078, transportation = $0.1506).

The handling of produce, including fresh tomatoes, from backroom storage to display case is usually performed using a two-shelf four-wheel cart, although shopping carts, two-wheel handtrucks, and manual pallet transporters are used. Three or four cases or cartons of tomatoes are stacked on the top shelf (waist high) of the cart in the storage area and transported to the display area as needed. After the tomatoes are removed from the cartons and placed in the display case, the empty cartons and cases are broken down and transported to the disposal area in the rear of the store.

Table 13 shows the labor and equipment time and costs to perform these operations. Total labor and equipment cost was 17.56 cents per carton.

Table 11. Labor time and costs for selecting, loading, delivering, and unloading cartons of fresh tomatoes stacked on mobile carts from warehouse to retail store as part of a mixed-produce trailer load[1]

Element	Per trailer load[2]	Per tomato load	Cost[3] Per tomato load	Cost[3] Per tomato carton
	Worker-hours	Worker-hours	Dollars	Dollars
Select cartons of product and stack on mobile carts	5.88	0.44	2.64	0.0352
Stock replenishment	.73	.05	.30	.0040
Load mobile carts into trailer	1.05	.08	.48	.0064
Deliver to store and return	3.79	.28	1.68	.0224
Unload at store	1.76	.13	.78	.0104
Total	13.21	.98	5.88	.0784

[1] Trailer load consists of 1,000 cases and cartons of product of which 75 are tomato cartons.

[2] Shaffer, P. F. and D. M. Steckler, Comparative Methods of Handling Produce from Warehouse Slots to Holding Areas in Retail Stores. ARS-NE-49, November 1974.

[3] At $6 per hour.

Table 12. Equipment time and costs for selecting, loading, and unloading cartons of fresh tomatoes stacked on mobile carts from warehouse to retail store as part of a mixed-produce trailer load

Element	Per tomato load	Cost per tomato load[1]	Cost per carton[2]
	Hours	Dollars	Dollars
Use of electric tugger	0.44	0.22	0.0029
Use of mobile carts	12.48	.37	.0049
Total	12.92	.59	.0078

[1] At $0.49, $0.03 per hour for the first and second cost data, respectively.

[2] For 75 cartons.

Table 13. Labor and equipment costs to handle fresh tomatoes from storage to display case using a two-wheeled cart at retail store[1]

Element	Labor[2]		Equipment[3]		Cost per carton[4]
	Time	Cost	Time	Cost	
	Worker-hours	Dollars	Worker-hours	Dollars	Dollars
Load four-wheel cart[3]	0.017	0.102	0.017	[5]	0.0255
Transport load from storage area to display case (105 feet one way)	.009	.054	.009	[5]	.0135
Place tomatoes in display case	.062[6]	.372	.062	[5]	.0930
Break down empty cartons, move cartons to disposal area, and return to storage area (105 feet one way)	.029	.174	.029	[5]	.0435
Total	.117	.702	.102	.0005	.1756

[1] Average round trip of 210 feet.

[2] At $6 per hour.

[3] At $0.005 per hour.

[4] Four cartons per load.

[5] Negligible.

[6] Time for placing loose tomatoes from the 20-lb. carton into the display case. Time for placing consumer packs from the 20-lb. carton into the display case would be less.

Comparison of Total Systems

Table 14 shows the cost to handle and transport a 20-pound carton of fresh tomatoes from the end of the packing line at the packing plant to the display case at the retail store. These costs per carton ranged from $1.0252 to $1.1384, a difference of more than 11 percent.

For shipment from the packing plant the synthesized pallet-pool system had the lowest cost (.6218 cents per carton) followed by the handstack system (.6249 cents per carton). The pallet and slipsheet systems had lower labor and equipment costs than the handstack system, but when the costs of the shipping platforms are included, the costs for these systems are more than the handstack system.

But, it was assumed that an additional transport charge was not made for the extra weight of the pallets in the palletized and pallet-pool systems. If a charge were made, this would increase the cost per carton in these two systems.

The pallet-pool system offers one of the best chances of keeping shipping costs down. The pallet-pool concept is not new, but has never been successfully operated on an industry-wide basis. This system is not considered viable at present; therefore, the handstack system should be used because the system is operational and costs only $.0031 more per carton than the pallet-pool.

From order assembly at this wholesale warehouse to unloading at the retail store, the pallet delivery system was found to be the lowest cost (.2278 cents per carton) system. Mobile carts were next (.2368 cents per carton) followed by the handstacked delivery system (.2598 cents per carton).

At the retail store, only one system was studied for movement of the fresh tomatoes from the temporary back room storage to the display case. The cost for this system was 17.56 cents per carton.

The total least-cost combination of systems for handling and transporting fresh tomatoes—from the packing plant to and through the wholesale warehouse to the retail store—would be a pallet-pool delivery to the wholesale warehouse and handling on pallets to the retail store. The total cost for this segment of distribution was .8496 cents per carton. When the cost for handling at the retail store is included (17.56 cents per carton) the total cost is $1.0252 per carton. The next lowest cost system would use the same handling procedure, except that the tomatoes would be handstacked at the packing plant and unloaded by hand at the warehouse. This system is recommended because it costs only $0.0031 more than the pallet-pool system and the system is operational. Therefore, the recommended system would be handstacked trailer loading and unloading from packing plant to wholesale warehouse and warehouse order assembly, delivery, and retail store unloading on pallets at a cost of $1.0283 per carton.

Wholesale and retail losses, due to damage and decay, have not been included in the systems cost comparisons. These losses will increase the total cost per carton, since fewer tomatoes can be sold at retail than were originally transported from the packing plant. Because of reduced handling, some systems offer better protection for the fruit than other systems. Therefore, losses will vary between systems.

Table 14. Total cost to transport and handle 20-pound cartons of fresh tomatoes from end of packing line or storage at packing plant to display case at retail store

System[1]		Costs per carton of tomatoes			
Packer to wholesaler	Wholesaler to retailer	Packing plant to wholesale warehouse	Wholesale warehouse to retail store	Retail store handling	Total cost per carton
		Dollars	Dollars	Dollars	Dollars
1. HS	HSD	0.6249	0.2598	0.1756	1.0603
2. HS	PD	.6249	.2278	.1756	1.0283
3. HS	MCD	.6249	.2368	.1756	1.0373
4. P	HSD	.7030	.2598	.1756	1.1384
5. P	PD	.7030	.2278	.1756	1.1064
6. P	MCD	.7030	.2368	.1756	1.1154
7. PP	HS	.6218	.2598	.1756	1.0572
8. PP	PD	.6218	.2278	.1756	1.0252
9. PP	MCD	.6218	.2368	.1756	1.0342
10. SS	HSD	.6334	.2598	.1756	1.0688
11. SS	PD	.6334	.2278	.1756	1.0368
12. SS	MCD	.6334	.2368	.1756	1.0458

[1] HS = Handstack
P = Pallet
PP = Pallet-pool
SS = Slipsheet
HSD = Handstack delivery
PD = Pallet delivery
MCD = Mobile cart delivery

Table 15. Development of hourly ownership and operating costs for equipment inputs for handling systems for fresh tomatoes

Type of equipment	Initial cost per unit	Years of depreciation[1]	Annual Ownership Costs			
			Depreciation	Interest[2]	Insurance and taxes at 4%	Total
	Dollars	Number	Dollars	Dollars	Dollars	Dollars
Forklift truck 4,000 lb capacity	11,000	10	1100.00	495.00	440.00	2035.0
Pallet jack	3,800	10	380.00	171.00	152.00	703.0
Forklift truck with push-pull attachment	14,000	10	1400.00	630.00	560.00	2590.0
Four-wheel selector truck	50	12	4.17	2.25	2.00	8.4
Pallet (48 x 40 GMAC)	6	3	2.00	.27	.24	2.5
Electric tugger	4,000	7	571.43	180.00	160.00	911.4
Mobile cart	200	5	40.00	9.00	8.00	57.0
Tractor	25,000	6	4166.67	1125.00	1000.00	6291.6
Refrigerated trailer	14,000	8	1750.00	630.00	560.00	2940.0
Roller conveyor	600	5	120.00	27.00	24.00	171.0
Four-wheel cart	50	12	4.17	2.25	2.00	8.4

[1] Straight line depreciation.
[2] Computed interest is 9 percent for half the equipment life prorated over the full life.
[3] Power cost for battery charging of electric-powered vehicles computed from manufacturers
[4] Maintenance of 1.5 percent of cost.
[5] Estimated.
[6] Based on 2,000 hours per year.
[7] 3,100 hours for tractors and 2,700 hours for trailers.
[8] 1,000 hours of use per year.

	Annual Operating Costs		Total Ownership and Operation Cost Per	
ower[3]	Maintenance[4]	Total	Year	Hour
ollars	Dollars	Dollars	Dollars	Dollars
16.00	165.00	461.00	2496.00	1.248[6]
16.00	57.00	353.00	1056.00	.528[6]
16.00	210.00	506.00	3096.00	1.548[6]
—	.75	.75	9.17	.005[6]
—	1.29[5]	1.29	3.80	.002[6]
—	60.00	60.00	971.43	.486[6]
—	3.00	3.00	60.00	.030
—	—	1.57/ mile	6291.67	2.029[7]
—	—	—	2940.00	1.089[7]
—	9.00	9.00	180.00	.180[8]
—	.75	.75	9.17	.005[6]